

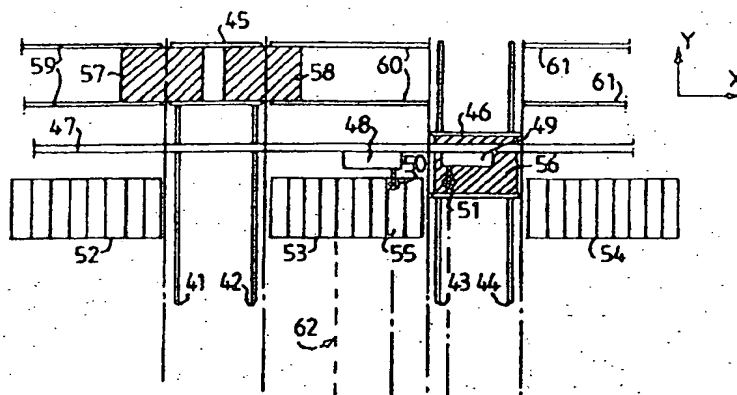
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(54) Title: A SURFACE MOUNT MACHINE CONCEPT



## (57) Abstract

A surface mount machine has a fixed X-axis (47) comprising a straight beam rigidly mounted in the machine chassis along which one or several wagons (48, 49) move(s), each one carrying at least one component pick-up device (50, 51). Below the X-beam for the X-axis (47) there are component feeders (55) which are organized in groups (52, 53, 54) and which are accessible by the pick-up devices (50, 51) and at least two Y-axes provided by linear bearings (41 - 44), which are rigidly mounted in the machine chassis. Y-wagons (45, 46) for carrying printed circuit boards move along the Y-axes. As there are at least two PCB carrying Y-axes, it can be arranged that at least one of them presents a PCB on which the pick-up devices (50, 51) can place components. The time during which the pick-up devices (50, 51) must be idle during PCB unload and load will thereby be dramatically reduced.

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A surface mount machine concept

## TECHNICAL FIELD

The invention is concerned with methods of designing and producing pick and place machines, in particular for the production of electronic circuit boards and specifically surface mounting machines.

## BACKGROUND OF THE INVENTION AND PRIOR ART

Machines for automatic assembly of surface mount components on printed circuit boards (PCB) are built according to a few basic mechanical concepts regarding the mechanical layout of their means to move PCBs into and out from the machine, their means to move the pick-up heads that pick components from component feeders and place them on the PCB, and their means - if any - to move PCBs and/or feeders during the pick-and-place operations.

Most machines used for such assembly can be considered to belong to three main groups illustrated by Figures 1 - 3, where Figure 1 shows a fixed X-axis, moving Y-axis machine, Figure 2 a rotary turret machine and Figure 3 a fixed X-axis, fixed Y-axis machine.

Figure 1 shows a machine with a fixed Y-axis shown as two linear bearings 1 and 2 and an X-axis 3 that is movable along the Y-axis. A carriage 4 is movable along the X-axis. On this carriage, there are one or several pick up heads. The machine picks components from the component magazine banks 6 and 7 by moving the pick up head 5 to a position above the selected component feeder, i. e. feeder 8, and moves thereafter to the printed circuit PCB 9, which is stationary during the assembly operation.

The natural way to arrange an automatic exchange of PCBs is to have a PCB conveyor 10 run in the X-direction of the machine. Far more than 50% of all component pick and place machines of the basic type shown in Figure 1 are supplied with integral PCB conveyors. The Surface Mount Equipment Manufacturers Association (SMEMA) in the USA has published a standard regarding the physical and signal interface between such PCB conveyors. An assembled PCB in position 9 can then be moved for example to the right on the conveyor 10 (passing the position 11) and a new,

empty PCB 12 can enter the machine from the left. Both PCBs will move in the same direction on the conveyor 10.

Figure 2 shows a machine with a turret 21 that stepwise rotates around an axis 22 that is stationary or fixed as seen in the X- and Y-direction. The turret 21 has a number of pick up heads in different positions, for example 23 and 24. The machine picks components from the magazine bank 25 by moving the whole bank 25 in the X-direction so that the feeder with the wanted component is placed in the pick up position 23, which basically is fixed. The component is picked up in position 23 and follows the turret 21 during the stepwise movement of the turret and will be mounted on the PCB when the head that picked the component reaches position 24. The PCB 26 is moved so that the correct part of the PCB is placed below the placement position 24. Practically all component pick and place machines of the basic type shown in Figure 2 are supplied with integral PCB conveyors. In Figure 2, a PCB to be assembled on the input conveyor is waiting in position 27 and a PCB that just have been assembled is in position 28, ready to be moved to the right on the internal conveyor 29.

Figure 3 shows a machine with a fixed Y-axis shown as two linear bearings 31 and 32. The fixed X-axis is shown as 33. A carriage 34 on which one or several pick up heads 35 are mounted can move along the X-axis in the X-direction. The machine picks components from two magazine banks 36 and 37 by moving the head 35 to a position above the selected feeder, for example 38, and mounts the component on the PCB 39 which is movable in the Y-direction.

#### SUMMARY

An object of the invention is to provide a pick and place machines, in particular a surface mount machine in which the time lost due to PCB board exchange is radically reduced.

Another object of the invention is to provide a surface mount machine that can be equipped with more than one independently movable pick up device and many feeders, and that permits full utilisation of the independent movable pick up devices even if the distribution of components in the feeders is badly balanced.

These object above are achieved by the invention, the characteristics of which appear from the appended claims.

Thus a mounting machine, in particular surface mount machine, has a fixed X-axis comprising a straight beam rigidly mounted in the machine chassis along which one or several X-wagons moves, each one carrying at least one component pick up device. Below the X-beam and the X-axis component feeders are located which are organized in groups or banks, which are accessible by the pick up devices. Also below the X-axis there are at least two Y-axes provided by linear bearings, which are also rigidly mounted in the machine chassis. Y-wagons for carrying printed circuit boards move along the Y-axes. There are at least two Y-axes for carrying boards and it is arranged that at least one of them presents a circuit board at a position on which the pick up devices can place components. The time during which the pick up devices must be idle during unload and load of boards will thereby be dramatically reduced.

Generally thus, in a method for placing components on boards, in particular electric or electronic circuit boards, there is at least one pick-up head which moves along a first direction, the X-direction, to a pick-up position where it lifts a component from a magazine, then it moves to a position above a board and finally lowers it to an accurately determined position on the surface of the board, where the component is released. The board, before the component is released, is, for an accurate positioning, retained by a holding device such as a wagon and is moved in a direction essentially perpendicular to the moving direction of the at least one pick-up head. This condition is to be considered in such a way that the moving direction of the board is essentially perpendicular to the movement direction of the pick-up head at the point where the path of the board intersects the path of the head. The movement of the board is then performed to such a position that when the component is placed on the board, the accurately determined position thereof on the board is achieved. Components are then or can be placed on at least two boards or two groups of boards at least partly simultaneously. The two boards or the at least two board groups

are both moved, for positioning and exchange of boards, independently of each other along fixed paths which are essentially parallel and/or intersect the path of the head in directions being essentially perpendicular to the path of the at least one head, as above at least in the intersection point, and in particular the boards or the at least two groups are moved to such positions that when a component is released from the head, an accurately determined position of the component on the board is achieved.

Then it is possible to achieve, that when one board or group of boards, that moves along one of the fixed board paths is moved away and is interchanged for a new board or a new group of boards, the at least one head continues to place components on a board or a groups of boards that moves along another fixed board path.

The components may then advantageously be picked up by two essentially identical heads which work in parallel and thus have essentially parallel paths. When one of the heads with a picked-up component is adjacent to or above a location on a board or a group of boards, movable along one fixed path, where the component is to be placed, and in lowering and raising movements of the head in this position, the other head can be adjacent to or above or in contact with a component in a magazine, which is to be picked up or shortly before has been picked up and is to be placed by this other head.

A mounting/pick-and-place machine for transporting components from magazines to predetermined locations on boards, in particular a surface mounting machine, thus generally comprises a first pick-up head or pick-up wagon. The head is movable along a path, the X-path, preferably an essentially linear path. The path of the head extends from places, where the head is capable of picking up components in magazines, to positions where the head is capable of placing components on a board. As conventional, the head includes pick-up means such as a vacuum nozzle for picking up components, holding them firmly during the transport and for releasing the components. Further, there is a first device for

holding a board or a group of boards, on which components are to be placed. The first device is movable along a path, a Y-path, having a direction essentially perpendicular to the path of the first head. The first device is also movable to locations where components can be placed upon boards or groups of boards, which are held by the device, by the first head. Such a machine is basically a prior art, one fixed X-axis, one fixed Y-axis machine. There is also arranged, however, a second device for holding a board or a group of boards, similar or identical to the first holding device. The second device is movable along a path, a second Y-path, having a direction essentially in parallel to the direction of movement of the first device and it is also movable to locations where components can be placed upon a board or boards carried thereby, by the pick-up head. This second holding device gives the machine an increased efficiency, especially can those time periods be more efficiently used when a board or a group of boards held by a holding device is interchanged for another one.

Further, it may be advantageous to even more increase the efficiency, to provide a second pick-up head which is movable along a path in parallel to or identical with the path of the first head, the X-path. The first and second holding devices should then be movable to locations where components can be placed, by the second head, on boards or groups of boards held by the second device.

Magazines for components, which are to be mounted on the boards, may be organized in at least two banks. A first bank is then advantageously located at one side of the path of the first holding device and a second bank is located at one side of the path of the second device in such a way that the two Y-paths of the holding devices are located between the banks or that none of the first and second banks are located between the paths of the first and second holding devices. Then the paths of the two holding devices can be located at each other allowing that a large or long board can be held by the two holding devices in combination. Also the two heads can more easily place components on a board or a group of boards carried by one of the holding

devices.

However, it may be advantageous to locate a third bank of magazines between the paths of the first and second holding devices. This will allow a larger degree of versatility when picking components and thus also for arranging the components which are to be picked and placed, at suitable positions for optimizing the mounting time of the boards.

A board conveyor can be arranged for conveying boards to and from the holding devices. The path of the boards conveyed by the conveyor are preferably essentially perpendicular to the paths of the holding devices allowing a easy loading and unloading of boards.

The heads can each one comprise, in the conventional way, a pick-up means, which is movable along a path having a direction, the Z-direction, which is essentially perpendicular to the paths of the heads and of the holding devices. The pick-up means can then be mounted in a mirrored fashion, so that they for instance are arranged at sides parts of the heads which face each other or in those parts of the heads, which are located most adjacent each other. It allows that the two heads can work at places in magazines or at boards located close to each other.

In another aspect of the machine, there is generally a first head as described above. However, there is a first holding device for holding a board on which components are to be mounted and a second holding device for holding a board on which components are to be mounted and a magazine holding components which are to be mounted on the boards. The magazine should then be located essentially between the first and second holding device. Such a design will allow the head to work at one board when the other board is exchanged for a new one, implying that the head in most cases will not have to be idle. Also, in this case, a second head like the second head above may be provided.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described and explained in more detail

with the reference to the accompanying drawings which illustrate embodiments and features of the invention. The drawings and embodiment are only described in the purpose of explaining the invention and are not intended to limit the invention. In the drawings

- Figure 1 shows a prior art fixed X-axis, moving Y-axis machine,
- Figure 2 a prior art rotary turret machine,
- Figure 3 a prior art fixed X-axis fixed Y-axis machine,
- Figure 4 shows a fixed X-axis dual Y-axis machine having three magazine banks,
- Figure 5 shows a time diagram of movements of two pick up heads of the machine of Figure 4,
- Figures 6a - 6c show the movements of the PCB and the various PCB conveyors of the machine shown in Figure 7, -
- Figure 7 shows a fixed X-axis dual Y-axis machine having two magazine banks.

#### DETAILED DESCRIPTION

The invention concerns in a primary aspect a concept for assembly machines having one fixed X-axis, used for pick-up devices, and two or more Y-axes, used for the movements of PCBs during the pick and place operation.

Figure 4 shows a machine of this kind. It has two fixed Y-axes shown as two sets of two linear bearings 41 - 42 and 43 - 44 respectively, these bearings thus all being parallel to each other. Two Y-wagons 45 and 46 are movable along these two Y-axes. The machine has one fixed X-axis 47 comprising for instance a straight beam equipped with suitable linear bearings. Two X-wagons 48 and 49 are movable along these bearings, thus along the X-axis 47. The machine further has three magazine banks 52, 53 and 54, each one comprising several individual feeders, arranged in parallel to each other, from which the machine picks components by moving a head like 50 to a position above a selected component feeder like 55, in one of the banks. It then can place the component on the PCB 56 by suitable movements of the X-wagon 48 and the PCB carrying Y-wagon 46, these movements thus taking place in the X-direction and the Y-direction respectively.

In the case where the X-wagons each one carries only one pick up head, the X-wagons 48 and 49 can advantageously be designed as mirrored images of each other, so that the pick-up head 50 of the left wagon 48 is placed as far to the right as possible and the pick-up head 51 of the right wagon 49 is placed as far to the left as possible, the sides of the wagons where pick-up heads are arranged thus facing each other.

Figure 4 shows the machine during an instant when the Y-wagon 45 is performing a PCB exchange. The PCB 58 has until recently been rigidly kept in a fixed position on the Y-wagon 45 and was then mounted with components, preferably from magazine bank 52 and the left part of magazine bank 53. The PCB 58 has thereby got approximately 50% of all components assembled and is during the instant shown in Figure 4 transferred to the PCB conveyor 60 simultaneously as a not yet assembled PCB 57 is fed into the Y-wagon 45 from the PCB conveyor 59.

A common problem with machine system using several heads is the balancing. In short series production, it is a waste of expensive operator time to optimise the placement of the component feeders in the magazine banks like 6 and 7 of Figure 1 or 52 - 53 - 54 of Figure 4 for every new board type. As long as a component type is available in an accessible magazine bank, it is advantageous if it can remain in its current position. The total assembly capacity of the machine of Figure 4 has a low sensitivity to the current position of the various feeders. This can be illustrated by a very simple algorithm that simply divides the machine in two logical machines similar to the one shown in Figure 3. This is done by introducing an imagined division boundary somewhere in magazine bank 53. One such border line is shown as item 62 in Figure 4. The PCB is first locked onto Y-wagon 45 and is then mounted with all components from magazine bank 52 and those components of magazine bank 53 that are located to the left of the line 62. Remaining components are mounted when the PCB is inserted in the other Y-wagon 46.

The system shown in Figure 4 can to some extent be regarded as two machines with a common basic frame. Unlike a system that

consist of two separate machines, the operating system of a machine like the one shown in Figure 4 can easily be arranged in a way that will keep both X-wagons active performing continuously meaningful assembly work. While components from the magazine banks 52 and 54 normally should be handled by the X-wagons 48 and 49 respectively, components from the central magazine bank 53 can arbitrarily be assigned to any of the two X-wagons. The only case when an X-wagon will be idle is in the case that more assembly time is needed to assemble the components taken from magazine bank 52 (or 54) than what is required to handle the components taken from both of the banks 53 and 54 (or both of 53 and 52). In embodiments where the banks like 52 are far longer than the X-wagons 48 and 49, both wagons can pick components synchronously also in the outer banks like 52 or 54.

The average pick-to-place distance for a machine according to Figure 4 will be less than for a machine according to Figure 3 with the same number of feeders. Therefore, each X-wagon in the machine according to Figure 4 will get a higher assembly capacity than a whole machine according to Figure 4 with the same number of feeders. As a consequence, each feeder in a machine according to Figure 4 will deliver more than twice as many components per hour as a similar feeder in a machine according to Figure 3 with one Y-wagon and the same number of feeders.

Figure 5 illustrates the X-movements of the two pick up heads 50 and 51 plotted against time during an assembly sequence. The Figure is very simplified in that the wagon movements required to catch reference point positions are omitted, the wagons carry only one pick up head each, the number of components picked for each PCB is very low, etc.

At the top of the Figure, the positions of the two heads as in Figure 4 are shown as points 50 and 51. The vertical axis of Figure 5 shows the time, and the position 70 along this axis corresponds to the instant in time illustrated in Figure 4. As the Y-wagon 45 at that time does not have any board in a mountable position, both X-wagons 48 - 49 and their heads 50 - 51 perform assembly operations on the PCB 56 that is carried by Y-

wagon 46. X-wagon 48 and its mounting head 50 can pick components from the magazine banks 52 and 53, but picks mainly from the part of bank 53 that is to the right of line 62. The X-wagon 49 and its head 51 picks components from bank 54. Each one of the two X-wagons or heads will to some extent be dependent of the movements of the other head, as the head 51 cannot place components far to the left of PCB 56 at the same time as head 50 places components far to the right of the same PCB. Furthermore, one wagon may have to wait while the Y-wagon 46 is moved from an Y-position that was suitable for the component just placed by the head of the other wagon to an Y-position that fits the component presently carried by its own head.

The loss of assembly speed due to the above described dependence of the two wagons of the movements of the other wagon can be substantially reduced or eliminated. The operation system can preferably select the components which are to be placed during the period when both wagons operate on the same Y-wagon.

At the point in time illustrated by item 71, the Y-wagon 45 have loaded the PCB 57 and placed it a mountable position. The machine can now be run as two almost independent systems, each running one X-wagon and one Y-wagon. In the time interval 71 - 72, each head can place components in any X-position on its Y-wagon and pick components from almost any feeder given the limit set by line 62. Access to feeders located close to the line 62 must however be restricted. When one wagon picks components from a feeder close to line 62, it will occupy parts of the space along the main X-axis 47 that the other wagon would require if it at the same time was to attempt to pick a component from a feeder close to line 62. During the time interval from time 71 to time 72, the operating system should attempt to place components that would cause synchronisation problems if placed during periods when both X-wagons have to operate on the same Y-wagon.

At time 72, all components required on the PCB 56 on Y-wagon 46 are already placed. As the Y-wagon at that time no longer has any PCB available for assembly, both X-wagons 48 - 49 and their heads 50 - 51 place components on the PCB 57 that then is carried by Y-

wagon 45. X-wagon 49 and its head 51 can pick components from the feeder banks 54 and 53 but should preferably pick from the left part of the centrally located bank 53. X-wagon 48 and its head 50 picks components from the feeder bank 52.

At time 73, the Y-wagon has loaded PCB 58 and placed it in an accessible position. The machine can now be run as two almost independent systems each having one X-wagon and one Y-wagon.

Unlike a system that consists of two separate machines, the operating system of a machine like the one shown in Figure 4 can easily be arranged in a way that will keep both X-wagons active performing meaningful assembly work continuously. This is possible as the time normally lost during board-exchange in most cases can be used in the operating mode where both X-wagons place on the remaining accessible board. This requires that the time required for two board exchanges is shorter than the time required for two wagons which simultaneously place on the same PCB to mount all components. Another way of expressing the same condition is that the time for mounting all components must be equal to or longer than the sum of the two time periods 70 - 71 and 72 - 73 in Figure 5.

Figure 7 illustrates an embodiment where there is no central feeder bank 53 but the Y-wagons move in path adjacent to and close to each other. The two Y-wagons Y1 and Y2 can then be made half as wide as normally required to handle the maximum PCB length. In the (rare) cases where very long PCBs have to be handled, the two Y-wagons can operate simultaneously and carry one and the same board. In this embodiment, it is thus no longer possible to divide the centre feeder bank in order to give both assembly heads the same workload. Instead, in this embodiment the remaining banks like 52 and 54 will normally be far longer than the wagons 48 and 50. Therefore, both wagons can pick components synchronously in the same bank like 52 or 54, albeit with a lower efficiency. On the other hand, the total length along the X-axis required for the two Y-wagons is reduced (in the extreme case with 50%), which permits more feeders to be kept in the same machine length. The possibility to let both heads operate on one

Y-wagon while the other Y-wagon performs a PCB exchange remains. The embodiment of Figure 7 is however well also suited to machines having only one X-wagon. Figures 6a - 6c show only the board feeder parts and Y-wagons of the machine, and the following description refers to a case where only one X-wagon is used.

Figure 6a shows the board conveyors when the wagon Y1 is changing from board A to board C. The new board C has earlier been fed from the fixed conveyor 81 to the load conveyor 82, which is movable in the X-direction and which in Figure 6a is in its home (left) position. The already assembled board A is fed onto the unload conveyor 83, which is movable in the X-direction, and which in Figure 6a is in its "pick-up from Y1" position. Assembly work is done on board B on wagon Y2.

Figure 6b shows the board conveyors in a case where both Y-wagons keep the boards C and B respectively in positions suitable for component placements. The next board D is being fed from the fixed conveyor 81 to the load conveyor 82, which is movable in the X-direction and which in Figure 6b is in its home (left) position. The already assembled board A is fed onto the fixed conveyor 84 from the unload conveyor 83, which is movable in the X-direction and which in Figure 6b is in its home (right) position. Assembly work is done on board C on wagon Y1 and on board B on wagon Y2.

Figure 6c shows the board conveyors when the wagon Y2 is changing from board B to board D. The new board D has earlier, as shown in Figure 6b, been fed from the fixed conveyor 81 to the load conveyor 82 when conveyor 82 was in its home position. The charge conveyor 82 has then moved to its "load Y2" position and is now moving the new board D into wagon Y2 at the same time as the already assembled board B is fed onto the unload conveyor 83, which is movable in the X-direction, and which in Figure 6c is in its home (right) position. Assembly work is done on board C on wagon Y1.

Figure 7 thus shows a fixed X-axis dual Y-axis machine with two magazine banks using the PCB feeding devices illustrated in

Figure 6. The machine has two feeder banks 152 and 154, one X-axis 147 with an X-wagon 148 carrying one pick up head 150. The two Y-wagons Y1 and Y2 runs on linear bearings 141 - 144, and the two X-wise movable load and unload conveyors run on linear bearings, of which one is shown as 86.

In the descriptions above, each Y-wagon is loading one board only at the same time. It is however preferable to load as many boards as possible on one single Y-wagon. If, for example, the number of boards loaded is increased from 1 to 4, the board exchange time (such as the time 70 - 71 and 72 - 73 in Figure 5) will increase only moderately, while the total number of components to assemble will increase 4 times. Loading four short boards on the same Y-wagon will therefore increase the time like 71 - 72 during which the two wagons can operate almost independently of each other much more than the time like 70 - 71 where the two X-wagons are much more dependent of each other. If at least two boards can be loaded on each Y-wagon, they should preferably be fixed close to the left and right end of the Y-wagon. Such placements of the boards on the Y-wagon will give greater freedom for the two heads like 50 and 51 to place components simultaneously, as the number of placement positions that are sufficiently far from each other in the X-direction will increase when a PCB is fixed at the left edge of the Y-wagon and another PCB is fixed close to the right edge.

In the descriptions above, each X-wagon like 48 is carrying only one pick-up head like 50. The wagons like 48 can however carry two or more pick-up heads that performs separate pick-up, a plurality of pick-up heads that normally performs simultaneous pick-up, a small multihead turret similar to the turret shown in Figure 2 with a vertical turret axis or a horizontal axis rotating multihead turret like the ones used in some machines manufactured by Siemens and Eurosoft.

In the description above, the two X-wagons share a common X-axis. Alternatively, two basically parallel axes or one common axis base with separate linear bearings can be used.

As is obvious for those skilled in the art, the invention can be implemented in many ways using concepts common in pick and place machines, which have not been shown or indicated in the description above. The pick-up operation of the pick-up heads can be performed using vacuum nozzles or mechanical pliers. The components can be centred using mechanical, optical image processing or other means. Components held by the pick-up heads must in most cases be rotated using extra means (not shown in Figure 4). Each magazine bank can be made as a single trolley permitting very quick feeder group exchange, as a group of quickly exchangeable feeder cassettes or be made as a stationary frame into which separate feeders are inserted. The system can mount components on other substrates than PCB, for example on thin film hybrid substrates. The actual position on the boards should in many cases be determined using optical fiducial reference points. This requires in most embodiments some extra movements, not shown in Figure 5, of the X- and Y-wagons to place X-wagon mounted cameras, not shown in Figures 4 or 7, above the fiducial marks, not shown in Figures 4 or 7, on the PCB. All movements of PCBs along the conveyors, movements of wagons, etc., require motors, not shown, and controller means like micro controllers, not shown.

## CLAIMS

1. A method of placing components on boards, in particular electric or electronic circuit boards, comprising that at least one pick-up head moves to a pick-up position where it lifts a component from a magazine, then moves to a position above a board and finally lowers it to an accurately determined position on the surface of the board, where it is released and that the board, before the component is released, is moved in a direction essentially perpendicular to the moving direction of the head, in particular at least at the point where the path of the board intersects the path of the head, the movement of the board being performed to such a position that when the component is placed on the board, the accurately determined position thereof on the board is achieved, characterized in that components are placed on at least two boards or two groups of boards at least partly simultaneously, that the two boards or the at least two board groups are both moved independently of each other along fixed paths which are essentially parallel and/or intersect the path of the head in directions being essentially perpendicular to the path of the head, at least in the intersection point, to such positions that when a component is released from the head, an accurately determined position thereof on the board is achieved.

2. A method according to claim 1, characterized in that when one board or group of boards, that moves along one of the fixed board paths is moved away and is interchanged for a new board or a new group of boards, the at least one head continues to place components on a board or a groups of boards that moves along another fixed board path.

3. A method according to one of claims 1 - 2, characterized in that the components are picked up by two essentially identical heads which work in parallel and that when one head with a picked-up component is adjacent to or above a location on a board or a group of boards, movable along one fixed path, where the component is to be placed, and in lowering and raising movements of the head in this position, the other head is adjacent to or above or in contact with a component in a magazine, which is to be picked up and placed by this other head.

4. A mounting/pick-and-place machine for transporting components from magazines to predetermined locations on boards, comprising

- a first head movable along a path, in particular an essentially linear path, the path extending from places where the head is capable of picking up components in magazines to places where the head is capable of placing components on a board, the head including pick-up means for picking up and releasing components,
- a first device for holding a board or a group of boards, on which components are to be placed, the first device being movable along a path having a direction essentially perpendicular to the path of the first head and to locations where components can be placed, by the first head, on a board or a group of boards carried by the first holding device,

characterized by a second device for holding a board or a group of boards which is movable along a path having a direction essentially in parallel to the direction of movement of the first device and which also is movable to locations where components can be placed by the head, on a board or a group of boards carried by the second holding device.

5. A machine according to claim 4, characterized by a second head movable along a path in parallel to or identical with the path of the first head, the first and second holding devices being movable to locations where components can be placed, by the second head, on boards or groups of boards carried by the holding devices.

6. A machine according to one of claims 4 - 5, characterized in that magazines for components are organized in at least two banks, a first bank being located at one side of the path of the first holding device, a second bank being located at one side of the path of the second device in such a way that none of the first and second banks are located between the paths of the first and second holding devices.

7. A machine according to one of claims 4 - 6, characterized by a third bank of magazines located between the paths of the first and second holding devices.

8. A machine according to one of claims 4 - 7, characterized by a board conveyor for conveying boards to and from the holding devices, the path of board conveyed by the conveyor being essentially perpendicular to the paths of the holding devices.

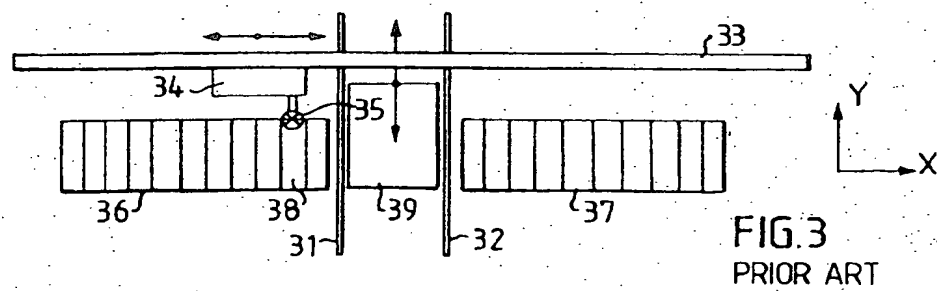
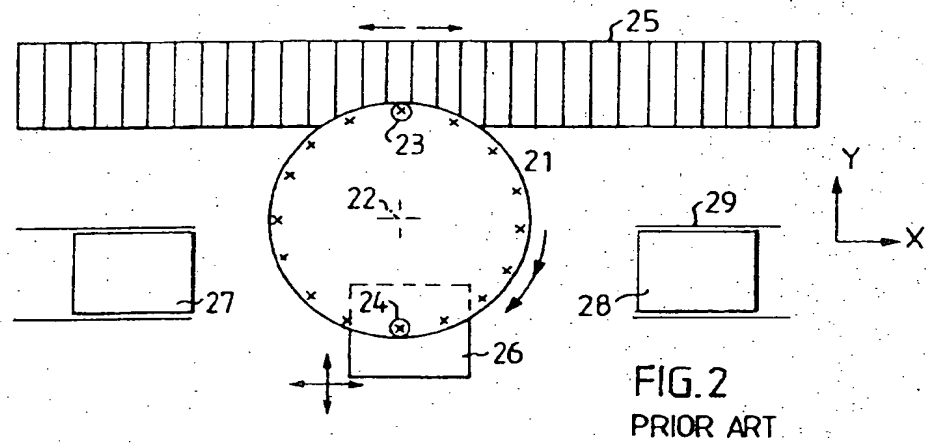
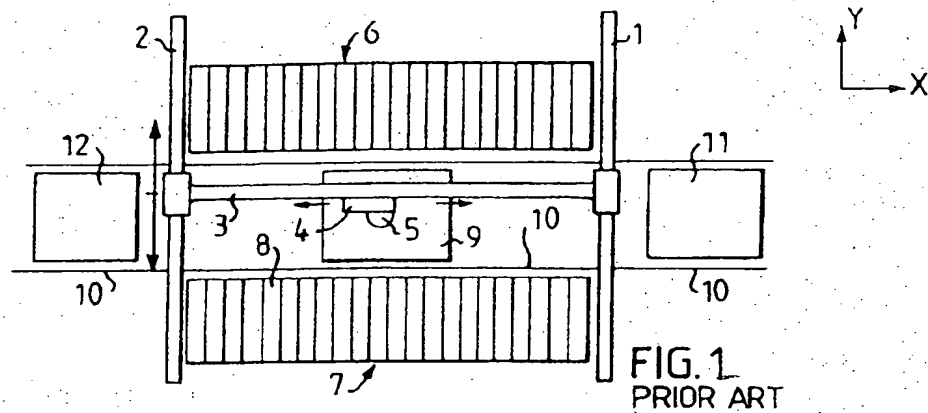
9. A machine according to one of claims 4 - 8, characterized in that the heads each one comprise a pick-up means, which is movable along a path having a direction essentially perpendicular to the paths of the heads and of the holding devices.

10. A machine according to claim 9, characterized in that the pick-up means are mounted at sides of the heads which face each other.

11. A mounting/pick-and-place machine for transporting components from magazines to predetermined locations on boards, comprising a first head movable along a path, in particular an essentially linear path, the path of the head extending from places where the head is capable of picking up components in magazines to places where the head is capable of placing components on a board or a group of boards, the head including pick-up means for picking up and releasing components, characterized in a first holding device for holding a board on which components are to be mounted, a second holding device for holding a board on which components are to be mounted, the path of the head being such that it can place components on a board or a group of boards held by each one of the holding devices, and a magazine holding components which are to be mounted on the boards, the magazine being located essentially between the first and second holding device.

12. A machine according to claim 11, characterized in a second head movable along a path, which is parallel or identical to the path of the first head, the path of this second head also extending from places where the head is capable of picking up components in magazines to places where the head is capable of placing components on a board or a group of boards, the head including pick-up means for picking up and releasing components.

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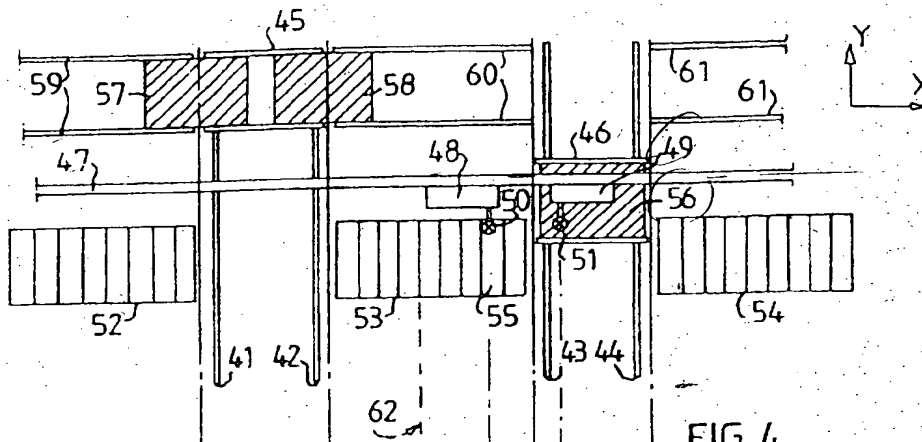


FIG. 4

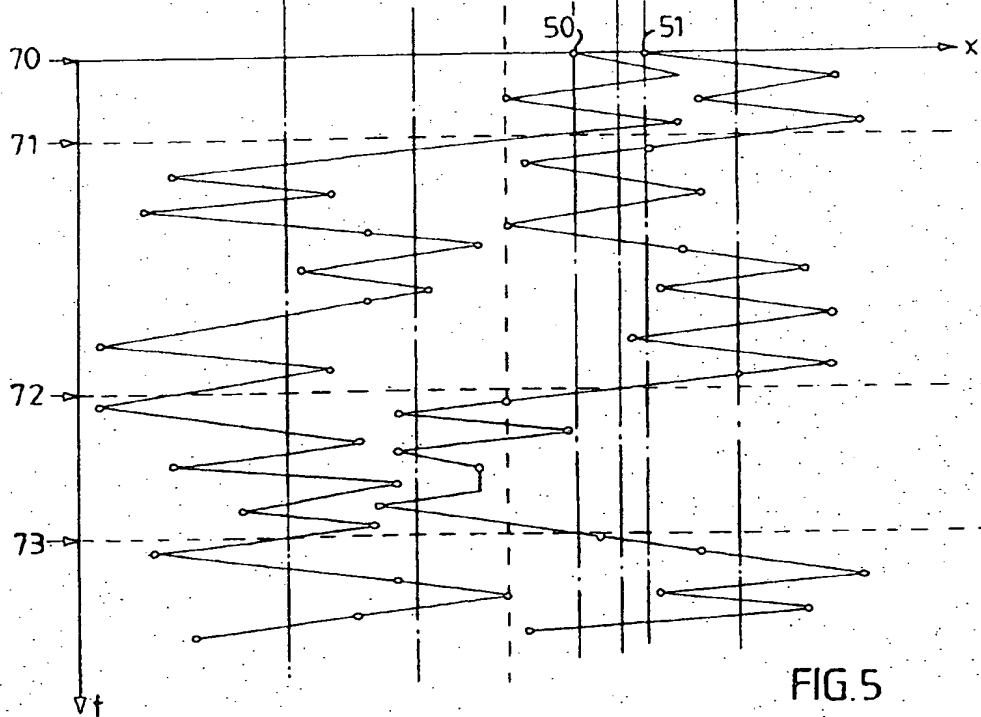


FIG. 5

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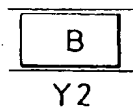
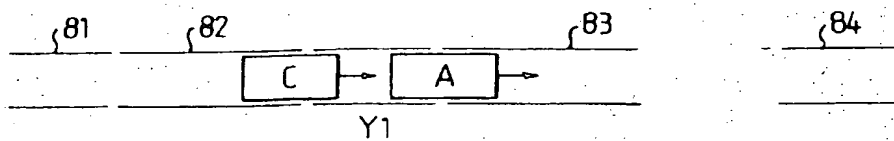


FIG.6a

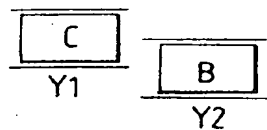
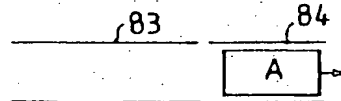
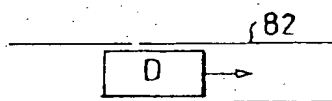


FIG.6b

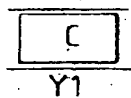
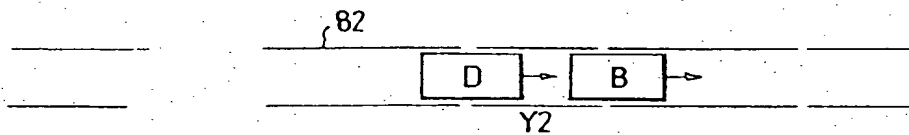


FIG.6c

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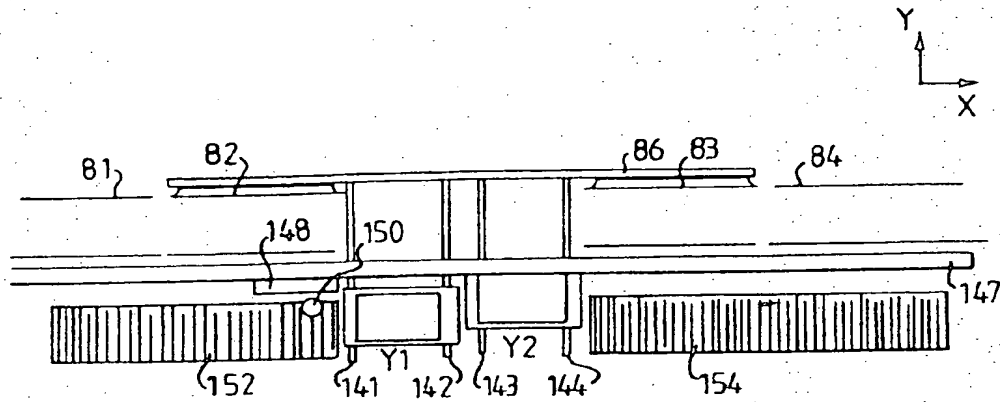


FIG.7

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 95/00015

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H05K 13/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB, A, 2173426 (DYANPERT PRECIMA LIMITED), 15 October 1986 (15.10.86), page 1, line 104 - page 2, line 86 --	1-12
A	EP, A1, 0248904 (MATSUSHITA ELECTRIC INDUSTRIAL CO. LTD.), 16 December 1987 (16.12.87), page 13 - page 14, figure 6 --	1-12
A	EP, A1, 0259489 (MATSUSHITA ELECTRIC INDUSTRIAL CO. LTD), 16 March 1988 (16.03.88), page 13 - page 14, figure 8 --	1-12

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

Date of mailing of the international search report

21 April 1995

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 95/00015

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP, A1, 0389048 (N.V. PHILIPS' GLOEILAMPENFABRIEKEN), 26 Sept 1990 (26.09.90), figure 1, abstract ---	1-12
A	EP, A1, 0453369 (EUROSOFT ROBOTIQUE), 23 October 1991 (23.10.91), abstract ---	1-12
A	WO, A1, 9111093 (ATS AUTOMATION TOOLING SYSTEMS INC.), 25 July 1991 (25.07.91), abstract -----	1-12

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

25/02/95

International application No.  
PCT/SE 95/00015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 2173426	15/10/86	NONE	
EP-A1- 0248904	16/12/87	WO-A- 8703235	04/06/87
EP-A1- 0259489	16/03/88	US-A- 4868977 WO-A- 8703234	26/09/89 04/06/87
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EP-A1- 0453369	23/10/91	AT-T- 111681 DE-D- 69103948 FR-A,B- 2661311	15/09/94 00/00/00 25/10/91
WO-A1- 9111093	25/07/91	EP-A- 0510027	28/10/92